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CONDITIONS GOVERNING TORPEDO-BOAT DESIGN.

BY LIEUTENANT R. C. SMITH, U. S. N.

It now seems to be a settled part of our policy to add largely to the number of our torpedo-boats. A recent article in the REVIEW described the steps hitherto taken to this end. The present writer submitted to the Naval Institute a study of the questions controlling future design, and from the character of the criticisms it is fair to assume that the ideas were generally accepted by the service as reasonable.

I propose to review now these governing considerations, which are really of a character to be easily intelligible to persons other than those who make a technical study of the subject.

Our guide at the start is the uses and limitations of torpedo-boats. These are best understood by a careful survey of foreign practice and opinion, based on the growth of a quarter of a century. The results only can be given here.

The prime end of a torpedo-boat is to attack and sink the enemy's ships, the secondary object to ward off the attacks of the enemy's boats. The weapon for the one use is the torpedo, for the other the gun and the ram. Can these two uses be reconciled in a single type of boat, adapted either for cruising with the fleet or operating independently along the coast, or for hurried raids from protected harbors? Or do we need several distinct types? Or can a boat of any size or type be used advantageously for all the duties?

In the attack on ships it is admitted without reserve that a total or partial surprise is the main element of success. In the absence of this feature the boats would be utterly destroyed by gun fire before they reached torpedo range. Hence attacks will almost invariably be made under cover of darkness or mist.

The boat, therefore, should be small to be as little visible and to present as small a target as possible, and should have a high speed to get quickly into action and quickly out. The main weapon is the torpedo, and there should be as many launching tubes as the size of the boat will permit. No guns are required for use against the ship; and were it not that the attacking boat might be headed off and put out of action by boats of her own kind or smaller, but carrying a battery of guns, there would be no necessity for any other weapon but the torpedo. In view, however, of the above possibility she must carry as many and as good guns as are usually to be found in the boats of the same size abroad.

For the second use, warding off the attacks of other boats, more and heavier guns and a higher speed are required. Other things being equal, this in itself points to an increased size of boat. Add to this that boats of this character should be capable of keeping the sea with the fleet in all weathers and to that end should carry more coal and stores, and also that they should afford a fair degree of comfort and habitability to their crews, and the necessity for greater displacement is manifest. The feature of invisibility must unfortunately be sacrificed to the extent demanded by these paramount requirements. Withal there will be occasions when surprises can be made, and in the melee of battle when torpedos can be used with effect; and for such uses launching tubes are provided, though there are not so many in proportion as in the torpedo-boat proper, where the torpedo and not the gun predominates.

The bows of all these boats can be so strengthened at the expense of a very moderate weight as to make them capable of cutting into the side of any similar boat or running through a smaller picket launch without material injury to themselves. Without seeking such occasions, which would involve many failures and consequent loss of time, it is very desirable to take advantage of them when they offer; as the enemy if struck would be quickly and effectually disposed of. In the navigation of our more northerly inland waters in the winter season, boats with bows so strengthened could safely cut through several inches of ice, a feature of decided possible value in time of war. The "Cushing's" bow has been provided with an interior fitting of this nature which has already demonstrated its usefulness by carrying

the boat totally unharmed through ice that would otherwise have crushed her bow plates out of shape.

The two uses enumerated have practically determined two types of boat, the torpedo-boat proper and the torpedo-boat destroyer, or briefly, torpedo-boats and destroyers, which terms are used hereafter in this special sense.

By limiting the torpedo-boat to operations from a shore base its size can be kept within reasonable requirements as to invisibility and inconsiderable extent of target. This is apparent when account is taken of the saving in weight effected by omitting the special features constituting a high-sea boat. These are coal endurance, seaworthiness, stowage space, habitability. The smaller boat must, however, sacrifice speed to a certain extent to be able to carry her torpedo and battery weights. The reason is that, to obtain a very high speed in a small boat, nearly all her carrying capacity must be given up to machinery and coal.

Here, then, must be studied the value of the required features, and a compromise effected that will give the best result as a whole. There is, of course, great latitude for individual opinion. The only logical way to approach the subject is to take up each feature in succession and fix for it two limits, the higher one such as to offer no inducement to pass beyond it, the lower one such that if not attained the whole object of the boat is defeated.

The features and qualities to be striven for are speed, invisibility, seaworthiness, carrying capacity for torpedoes and guns, coal endurance, stowage capacity, habitability. Taking these up in order, and with regard first to the torpedo boat, what are the limits of speed that should be established? The object of speed in a torpedo boat is to pass quickly through zones of fire, to escape from destroyers, and to be able to strike suddenly and unexpectedly from a distance. Generally speaking it should be as high as is compatible with other requirements. Naturally it cannot be expected to equal that of the destroyers, except by an almost complete sacrifice of other essential features, such as endurance, or carrying capacity. Torpedo boats must gain the advantage of destroyers by numbers, and not by speed. Some must be sacrificed so that others may pass through.

But when it comes to the supreme effort of the torpedo-boat, the attack of the ship, is excessive speed after all the main requirement? It is such a fashion to make speed the sole criterion

of excellence in this craft, that a suggestion of anything else is almost startling. Newspaper publicity and the rivalry of builders are responsible for the fashion. Besides, speed appeals to the public, and it is something tangible to offer for comparison.

It has been mentioned that the attack should be made under cover of darkness or mist, and must be in a measure a surprise. Consequently the boats in approaching will avoid anything like noise or commotion or any visible display that might indicate their presence. At any excessive speed the rush of water is audible at a considerable distance under favorable circumstances. There is usually a white crested bow wave and always a white streak of disturbed water in the wake. Then as the fires are forced there will be tongues of flame at the funnels. These are evidently not favorable accompaniments for a surprise attack. The alternative is to proceed at a moderate speed. In the "Cushing" with a maximum speed of 24 knots it was found that it was not advisable greatly to exceed 12 at this stage of the attack.

Now, as the result of many exercises at the Newport Torpedo Station, it appeared that the average distance at which the boat could be discovered with the aid of searchlights was 781 yards. These exercises were all held in good weather on nights of varying darkness, and under conditions generally favorable to the defence. The accepted torpedo range for a number of years has been 500 yards. Hits at this distance should be very probable, and especially now in view of recent improvements in torpedoes and in particular of the adoption of an automatic steering device which holds the torpedo very accurately to its course. When the boat is discovered concealment is at an end, and it is an object to dash in at top speed until the distance intervening from the point of discovery to the limit of torpedo range is passed. At 24 knots, now readily attained in torpedo boats, it would require 21 seconds to pass this interval of 281 yards (781 yards less 500 yards). Something would have to be added to this to allow for the time of working up to full speed after discovery. Now suppose that 30 knots was the maximum speed of the boat. It would mean reducing this interval by a fifth, or something over 4 seconds. But 30 knots in a small boat means the sacrifice of nearly everything else. Is it worth the price? It may be added that the length of time thought to be necessary to put a single boat out of action when in sight and beyond torpedo range

has varied between 1 and 3 minutes as instanced by the rules in foreign naval manœuvres. In the English manœuvres of 1896 it was quoted as 2 minutes.

So much for the question of speed. As mentioned above, 24 knots can be readily obtained. When the other requirements are determined, if a higher speed can still be secured, then so much the better; otherwise, 24 knots will be sufficient.

Next as to invisibility. It is evident the smaller the boat, from this point of view, the better. This is the feature of those quoted that is opposed to all the rest. Speed, seaworthiness, capacity, endurance, and habitability all call for increased tonnage. Still, the quality of invisibility is of such vital importance that it is imperative to consider most carefully any feature that tends to impair it by increasing the size of the boat. It is known from our own experience that boats of about the size of our "Cushing" or "Ericsson" are very difficult to pick up at night when painted the dark olive color now adopted for torpedo-boats. This color, by the way, was developed as the result of several years' experience under the searchlight at Newport. Though called green it really has no green in it. It is made up of white, black, and yellow of proportions in the order given.

This size of boat, moreover, conforms to the latest practice abroad in torpedo-boats proper, and it is fair to assume that it is warranted by the experience of foreign nations. When it comes to the question of a larger size, it is a great temptation to say this will give us a little more speed or greater seaworthiness. That is true, but is the game worth the candle? The first idea occurring to any one who sees the new torpedo flotilla together is how very much more conspicuous than the "Cushing" and "Ericsson" are the later additions; and yet their torpedo armaments are all the same. In a surprise attack on a hostile ship I should prefer the "Cushing" by all odds to any of them, notwithstanding that her maximum speed is three to five knots less than that of the others. Greater speed should mean greater powers of offence as well, and it will be seen that this points to a very much larger boat. There seems to be no reason whatever for adopting any intermediate sizes. Some of the features can be improved on, but to a point which gives no substantial gain, and at the sacrifice of the prime requisite for a surprise attack against ships, namely, invisibility.

The other features may be discussed together. These boats are intended to operate along the coast, to be independent of the squadron and to return to port in bad weather or to replenish stores. For such purposes the "Ericsson" is perfectly seaworthy. She could stay out in weather in which a much larger boat could not handle her torpedoes. She carries three torpedo-tubes, which are ample, and she could carry heavier guns than her present 1-pounders, which an authority as great as M. Normand, in speaking of the French first-class boats, describes as an arm absolutely without value. Her coal endurance is ample, approximately a day at full speed or a week at economical steaming. Of stores of all descriptions she can carry enough to outlast her coal, and she is entirely habitable if advantage is taken of her return to port to assure her crew of a complete rest if they need it.

The question of guns for these boats deserves some further remarks. Their main object is for attacking or resisting boats of their own class. Four 3-pounders are the armament of some foreign boats, and it is higher than the average. The automatic 3-pounder seems to me the ideal gun for this purpose. The question of reliability, to be determined on trial, will affect the decision. This gun could also be used with effect against destroyers when hard pressed and might by a lucky shot bring the boat out safely. A torpedo boat engaged in an attack should pay no attention to picket-boats, except to run over them if they are in the course. By firing she attracts attention to herself from the ship, whereas if she keeps straight on she may still get within torpedo range before she is discovered.

There is, of course, the probability that we shall never be attacked on our own coast by torpedo boats proper, though it is possible that destroyers might be sent against us. It is, therefore, sometimes argued that as our torpedo boats cannot hope to contend with destroyers, it would be better to save the weight and not arm them with guns at all. But I think the better view is that they might, as above stated, save themselves by a lucky shot if they carried a few suitable guns, and they could then scarcely be boarded at anchor and captured by a boat expedition, which might conceivably happen if they carried no guns whatever. The small-calibre machine gun is sometimes advocated for these boats, with the idea of using it against the crews of picket or other smaller boats. But as stated above, it does not seem advisable to

fire at all under these circumstances, and the machine gun would be of no use whatever against destroyers.

The destroyers are a type developed by the English and date from 1893. They are in appearance large torpedo boats, but they carry a much heavier gun armament. Their object is to keep the sea in all weathers with the fleet, and to overhaul and destroy torpedo boats. Secondly, they are to attack ships when occasion favors, and to this end they carry a limited torpedo outfit. When the type first appeared it was contemplated to arm them with guns only. But as they would then have been harmless against ships, and would have no means of defence except their speed, it was decided to add a few torpedoes. The conditions imposed required a decided increase in displacement. Speed, endurance, and carrying capacity were to be enhanced. The feature of invisibility had to be sacrificed ; but as their main object was to ward off and destroy torpedo boats, this was not an insuperable objection.

The earliest of these boats, the "Havock" and the "Hornet," much resembled our "Porter" and "Dupont." They were 5 feet longer and of 40 tons more displacement. Since then the size has materially increased. The latest of them displace nearly 400 tons and the speed is to be 32 knots. The armament is two torpedo tubes for the long 18-inch Whitehead (16½ feet by 18 inches), one 12-pounder and five 6-pounder rapid fire guns.

We see at work in the development of the type the same influences that tended to produce larger and larger torpedo-boats with speeds higher than required and an area of target that at the sacrifice of invisibility almost defeated the object of their creation. This is due to the rivalry of builders, whose success is judged by speed alone. If this growth continues we shall have gunboats instead of destroyers, with a high speed it is true, but with a draught that precludes their following torpedo-boats into shoal waters, and of a size that puts their use as torpedo-boats almost out of the question. With us the requirements of canal navigation should effectually put a stop to this increase.

If the feature of invisibility is taken to limit the torpedo boat to about 120 tons, then all the requirements of the destroyer can be satisfied in a boat of less than 300 tons, and it would seem merely fatuous to pass beyond. Bearing this in mind our destroyers, if limited to a displacement of from 250 to 300 tons,

will still stand a chance when used as torpedo boats proper, though evidently not the equal of the smaller craft for this purpose alone. Their displacement will warrant a speed higher than that of any torpedo-boat; they will be seaworthy, and habitable, and have a coal endurance and capacity enabling them to keep the sea at all times with the fleet. This is the limit of size for our coastwise canals.

Their torpedo armament can well be that of the smaller boats, *i. e.*, three tubes for the long 18-inch, and there will still be room for a formidable gun armament. If the 3-pounder is of sufficient power for the attack of a similar boat, why go to 6-pounders and 12-pounders as the English have done? I think in lieu of the one 12-pounder and five 6-pounders, that eight automatic 3-pounders would prove a more formidable battery and would have the advantage of a saving in weight. Nor are the advantages of a single calibre of ammunition to be lost sight of.

Thus it seems that keeping well in mind the uses to which torpedo-boats and destroyers are to be put, the limitations in each case will produce two entirely distinct types of boats. There does not seem to be the least object in merging these two types in one by building boats of intermediate sizes. By so doing the objects of the torpedo-boat proper are defeated and those of the destroyer are not attained. There will also be produced a heterogeneous flotilla incapable of manœuvring for any common object. This state of affairs will inevitably be produced by permitting builders to set their own dimensions and displacements. I believe it would be wise to use the terms destroyer and torpedo-boat in appropriation acts to indicate the character of the boat, and then for the proposals to indicate very nearly the displacement, speed, trial weights, and total coal endurance. The builders would then have an opportunity to display their skill within the settled requirements in such directions as design of hull with regard to speed, lightness of construction consistent with strength, and horse-power in proportion to weight of boilers and machinery. Then by requiring all speed trials to be made at normal displacement it would be easy to compare the performances of rival boats. A simple definition of normal displacement is the displacement with all torpedo and battery weights aboard, the crew and their effects, all permanent stores, and one half the full amount of coal and perishable stores.

It is conceivable that nations may be so situated as to make their torpedo-boat policy very variable. The English, for instance, predominate over other powers in regard to ships. They are willing to trust their ships to take care of the enemy's ships. With regard to torpedo boats they prefer not to have many, but to possess enough destroyers to look after all the enemy's boats. In our own case, as before stated, it is not probable that hostile torpedo boats will be encountered on our coast, but it is possible that we may meet destroyers. As we are not in the first rank in respect to ships, we can well rely largely on torpedo boats to help us out; and as we shall require destroyers to meet those that may be present in the enemy's fleet, it is evident that it is the part of wisdom to build both types; but for the present we would seem to need more of the smaller ones.

Nothing has been said here of the means of defence that would be used by ships against these craft. Torpedo nets are out of vogue, and as has been stated, the searchlight cannot be relied on to pick up the boats early enough to ensure their destruction. A squadron at anchor within striking distance of torpedo-boats would be almost at their mercy if unprovided with other means of defence. The logical defence is a flotilla of destroyers. These would cruise about the anchorage within signal distance of each other, and some would be detached to scout for torpedo-boats. Then, nearer the ship would be vedettes and picket-launches to give the alarm. Searchlights are condemned by all the best authorities prior to the actual discovery of the attacking boat. They blind the eyes of the lookouts and they serve as a lighthouse to the enemy. Their only use is to light up the target offered by the approaching boat.

At sea the squadron should cruise with lights concealed and with scouts and destroyers surrounding it on all sides. We have the beginning of a fine fleet of vessels, but we are almost entirely helpless in the means of saving them from one of the most destructive foes they are liable to meet, and one whose importance and power of offence are constantly increasing.

R. C. SMITH.